WPD INNOVATION
Transforming the electricity network

Temporary Event Charging

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Disclaimer

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1. Executive Summary

The Temporary Event Charging project was an Ofgem Network Innovation Allowance (NIA) project carried out between December 2020 and October 2021 with a budget of £118,000. This feasibility study project aimed to design and assess Electric Vehicle (EV) charging solutions for temporary events, including music festivals and sporting events. This research was carried out in response to the increasing requirement for events to provide EV charging in line with the UK government targets for phasing out internal combustion engine vehicles.

The project carried out two Work Packages (WPs). The first WP undertook background research on current practices and the need for EV charging at events, before collecting data on events carried out within our licence areas and selecting three for the later stages of the project. The case studies selected represented a range of event types, scales, locations, attendee numbers and durations.

Within Work Package two, solutions were then developed for each of the selected case studies, including base case network connections, and counterfactual tee'd connections, temporary connections, timed connections and battery energy storage systems (BESS). For each of these, implementation requirements were identified and capital and operating costs were outlined. Workshop sessions with our internal teams were used to generate practical ideas and to ensure implementation with our policy and design practices was considered in each design. The outputs of this work were then used within a Net Present Value (NPV) Cost Benefit Analysis (CBA).

Our research and CBA has led us to the conclusion that portable BESS are the optimal power solution to supply forecast EV charging demand at temporary events, therefore, the Distribution Network Operator (DNO) will not have any role in the provision of the EV charging infrastructure at the event site. It has therefore been found that there is no scope for a future NIA funded trial as any future work would need to be funded directly by the events industry in coordination with their EV charging delivery partners. The project has demonstrated a need for further development in this area, and it is recommended that EV charging delivery partners and event organisers look to build on the learning and findings presented during the course of this project.

This project has been successfully carried out within its planned timescales, with minor variance in budget due to there not being any need for any contingency spend and a small reduction in expected project management time. During this process, all aims, objectives and success criteria have been met.

2. Project Background

Temporary events, including festivals and sporting events, attract a large number of attendees each year, with a large proportion of these attendees needing to travel by car due to the limited travel infrastructure available in rural areas. Every year there are over 500 festivals across the UK which host 4.9 million festival goers. As the number of EVs increases in line with government targets to decarbonise transport there will be a need for significant charging capacity at these events. Currently events provide limited charging points and existing charging methods include utilisation of diesel generation or making permanent network connections which is not economically viable for a short period of use. Providing connections to these sites would come at a large cost which would be split between the site owner and the DNO and its customers, therefore an alternative solution is required for this problem.

This project aimed to solve the problem by designing solutions for charging the EVs used to travel to events and assessing their feasibility for further trial and development. Scenarios where charging infrastructure would be required were defined and solutions to these were developed and included temporary network connections and battery storage.

This feasibility study project consisted of two work packages. The first involved carrying out background research before defining case studies for development. The second then designed and developed solutions for each case study, before carrying out cost benefit analysis and assessing the suitability for a future trial project.

The project was carried out by Connected Kerb and GHD. Connected Kerb has experience of designing and providing electric vehicle charging infrastructure, and GHD are experienced in providing support with multi-work package innovation projects with significant expertise in distribution network planning and design and techno-economic analysis. GHD have previously designed connection solutions for the connection of innovation equipment to the distribution network as well as creating testing specification and review.

3. Scope and Objectives

The project has met the objectives set out when the project was registered as demonstrated in Table 3-1 below:

Table 3-1: Status of project objectives

Objective	Status
Improve knowledge on how to accommodate charging at temporary events	✓
Design solutions for charging at a range of events	✓
Determine the benefits of using temporary connections to achieve EV charging at events	✓
Determine whether a demonstration project is appropriate	✓

4. Success Criteria

The project has met all of the Success Criteria set out when the project was registered as demonstrated in Table 4-1 below:

Table 4-1: Status of project success criteria

Success Criteria	Status
A set of concept designs for providing temporary event charging at festivals for a number of case studies are presented	✓
Capital costs are outlined for each design and this feeds into CBA in respect to DNOs and their customers	✓
Benefits of making temporary connections over existing methods of connection or on site generation are presented	✓
Outline of how solutions will fit within WPD policy and PSD practices is documented	✓
A conclusion is given on whether a trial is suitable for temporary connection solutions	✓

5. Details of the Work Carried Out

This feasibility study project designed solutions for charging EVs at temporary events before assessing their feasibility for future trial and implementation across the UK. Our research and Cost Benefit Analysis (CBA) has led us to the conclusion that portable battery energy storage systems (BESS) are the optimal power solution to supply forecasted EV charging demand at temporary events. The BESS solution was beneficial both technically and financially when compared to the other solutions namely temporary and permanent network connections to the local 11kV network. They also provide a readily deployable, flexible and scalable system. For longer duration events dedicated high power EV Charging Points (EVCPs) for recharging the portable units could be installed at the local substation. This would give the portable units unhindered access for recharging, allowing improved flexibility for the temporary event organiser and reduce the risk of depleted supplies.

New network connections to supply the forecast EV demand were found to be significantly more expensive even when a temporary event is located in close proximity to an existing primary or secondary distribution substation. The new network connection designs required the installation of secondary distribution substations and associated 11kV overhead lines (OHL) and/or cabling that was deemed cost-prohibitive for the very short duration the assets are utilised for over the year. In addition, the required reinforcement works could cause significant disruption to network customers and landowners. Furthermore, this solution could also add complexity and uncertainty in the commercial arrangements for the connection, considering the capacity may only be used over a short period of the year. Added to this, the recent pandemic has severely impacted the events industry and it is unclear, at least in the short term, the ability for the event organisers to bear the full investment required in network connections for EV charging and still run a profitable event.

Our investigation has shown that low power EV chargers (up to 7kW) are the most suitable solutions at temporary events given that EVs tend to have a long dwell time over the temporary event duration. These types of chargers can be installed and configured relatively quickly and with little disruption in a suitable parking location in proximity to the temporary event. Charging infrastructure is most easily deployed where it is surface mounted, self-weighted and interconnected with concrete and rubber cable tracks to hold the equipment safely and securely in place.

The location of the chargers should ideally be located for best access for the power source, either based on optimal cable connection to a substation or easiest access for the vehicles delivering the BESS. A key consideration for the installation location is ensuring access for disabled drivers is not restricted or compromised by the roll-out of on-site EV charging infrastructure.

The BESS solution can be implemented and carried out by the event organiser, or more likely contracted out to a third party that has experience in installing and configuring BESS solutions. Therefore, the DNO will not have any role in the provision of the EV charging infrastructure at the event site. The scope of a future NIA funded trial is limited based on this learning as any future work would need to be funded directly by the events industry in coordination with their EV charging delivery partners.

The work within this project was carried out within two distinct Work Packages:

5.1. Work Package 1 – Case Study Selection

Work Package one began by carrying out background research on the need for EV charging at temporary events, before reviewing the existing practices in place to support charging for the number already seen at events. The outcome of this demonstrated the need for future charging solutions, but currently limited charging facilities are provided. To date EVs have not been a significant consideration for most event organisers, however, this is changing. Event organisers recognise that more people will attend events in EVs and some have already received requests from attendees for charging facilities.

An exercise was then carried out to explore options for the case study selection process, and data on events within our four licence areas was gathered. This was undertaken using direct engagement with event organisers, local authorities, parking management companies, and online desktop research. As the project was carried out during the COVID 19 pandemic, the engagement with local authorities and parking management companies was found to be the

most effective way of accessing further data on events who at the time were operating small teams of staff. Once all the data was gathered, the event options were scored to select those that would be taken through to the solution development stage. The requirements for these case studies including a duration of over two days, attendance of over 10,000 people, and greater than 30% of attendees travelling by car. As well as this, the need for diversity within the case studies was also considered, so the selected events represented a range of types (music festivals and sporting events) and durations (attendees dwell time of between one and seven days).

The events selected to be taken forward to work package two were Glastonbury music festival, Boardmasters music festival and Badminton Horse Trials.

5.2. Work Package 2 – Case Study Analysis and Design

Work Package 2 began by further building the case study data and technical information help for each event. Work was carried out to identify nearby network assets and topologies to begin the planning and design of network connection options. Following this, engagement began with our internal teams to consider how solutions would fit within our existing and future practices and design methodology. As such, workshop sessions were carried out with attendees including staff from our teams responsible for policy documents and design in the case study local area. These workshops were held to identify solutions that were realistic and practicable, whilst also identifying key considerations and barriers to the practical delivery of the solutions. A summary of the items discussed in the workshops included:

- Forecast charging demand at each site;
- EV charging usage patterns and alternative connections;
- Existing network infrastructure and arrangements at each case study site;
- Likely point of connection for new substation capacity;
- New circuit and substation locations and planning requirements;
- N-1 requirements for temporary event EV charging demand;
- Timed connection options where firm capacity is not available; and
- Earthing and security implications of temporary network connections.

Outputs from this fed into the design work carried out for each case study. For each case study a suite of possible solutions was developed. This included a base case of a traditional network connections, and counterfactual solutions of temporary network connections, timed connections tee'd off local HV network, and BESS systems under both leased and purchased models.

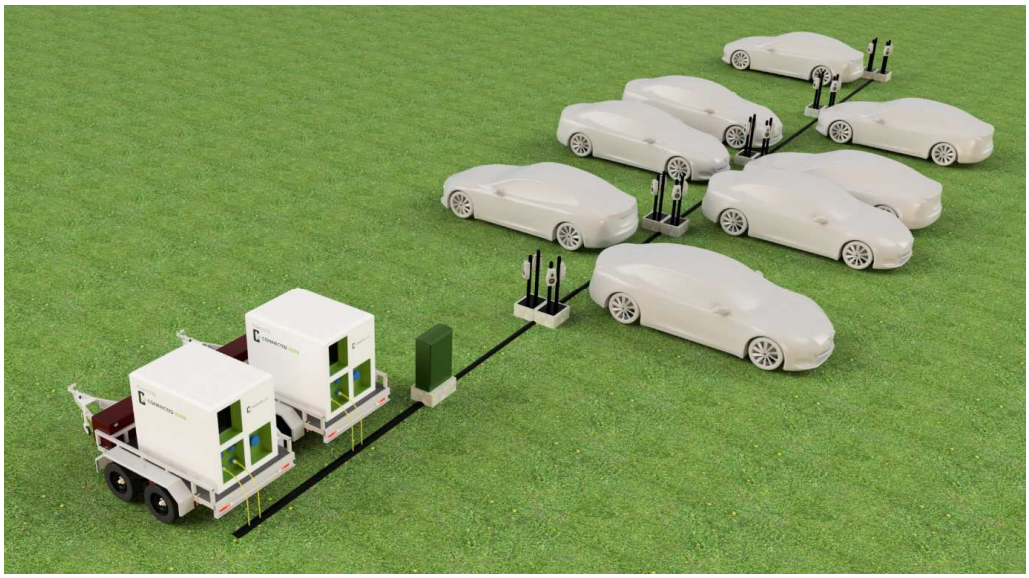

Figure 5-1 Modular Portable BESS site layout

The base case solution for providing EV charging was the installation of permanent new substation(s) and associated HV Overhead Line (OHL) or cable circuits either to the local 11kV ring, or back to the closest 33/11kV primary

substation. As temporary events are typically held for a few days per year, we assessed temporary network connection solutions that could be deployed solely for the event duration. This could reduce the capital expenditure associated with a permanent equipment installation and avoid underutilised assets.

Temporary EV charge points were also specified for each of the case studies. During the first work package various stakeholders including those managing the events were engaged. This engagement defined what was required to provide efficient set up and break down of event equipment as well as ensuring the EVCPs were securely mounted and visible to users and event organisers that may be utilising the EVCPs. This analysis led to a post mounted EVCP. The project designed the connection process that this would require and outlined what the earthing and protection system would look like.

Figure 5-2 Photograph of proposed EVCP arrangement for temporary events

Cost Benefit Analysis was carried out to determine the most effective solution for each of the case studies identified both for the events and their organisers, to determine which would likely to be selected for use, and in respect of the DNO and its customers. Net Present Value (NPV) analysis was undertaken for each case study including both capital and operating costs over a life cycle of ten years. The NPV analysis used Ofgem's Net Benefit Discount Factor (3.5%) to discount all costs and benefits over the lifetime of the solution and Ofgem's RIIO-ED1 CBA template was used as a starting point for the analysis. Table 5-1 below shows a summary of the whole life cost for each case study selected and each solution developed.

Table 5-1: Summary of Solution Whole Life Costs (10 years)

Solution No.	Description	Boardmasters	Badminton	Glastonbury
1	Timed Network Connection - OHL	£463,080	£1,099,666	£1,869,191
2	Timed Network Connection - Cable	£451,279	£1,086,470	£1,867,149
3	Purchased BESS	£917,045	£2,035,625	£3,819,985
4	Leased BESS	£386,475	£991,250	£1,378,091
N/A	Base Case	£661,848	£2,255,647	£2,023,093

For event organisers, the leased BESS solution type was found to be the most cost-effective for each case study. This solution minimises the capital expenditure that event organisers would need to make to facilitate the forecast EV charging demand at each case study event. In addition, the installation, commissioning, and decommissioning would most likely be carried out by a third party, thus reducing the cost burden on the event organisers.

A leased BESS solution would also be the most cost-effective solution for the Distribution Network Operator (DNO) as this option does not require the installation of additional network infrastructure, and therefore there would be no socialised costs attributed to network customers.

If battery leasing is not a solution that can be considered by the event organiser, the next most cost-effective solution for the DNO would be to implement a tee'd connection from the local 11kV network and offer an alternative timed connection to the event organiser. This would encourage EV charging to take place during defined 'off-peak' time periods. In this way the EV charging demand will not exceed existing peak demand on the HV circuit, mitigating the need for additional network reinforcement.

For further information on work carried out within this project please see the detailed Temporary Event Charging solution design report which can be found on the project page on the WPD Innovation website: www.westernpower.co.uk/projects/temporary-event-charging

6. Performance Compared to Original Aims, Objectives and Success Criteria

6.1. Objectives

The Project has satisfied the original aims and objectives as detailed in **Error! Reference source not found.**.

Table 6-1: Performance compared to project objectives

Objective	Status	Performance
Improve knowledge on how to accommodate charging at temporary events	Complete	• Knowledge improved on how to accommodate charging at temporary events by the development of a range of solutions for use at multiple events. • This includes knowledge on how solutions can be connected to the distribution network, how solutions can make use of battery storage solutions, and what the charging infrastructure should look like for temporary solutions. • This knowledge applies to DNOs, events, and charge point operators.
Design solutions for charging at a range of events	Complete	• Multiple solutions designed for the three events identified as case studies during the course of the project. • This includes portable battery storage options and network connection options. • The project selected three events as case studies, and this included a range of timescales and event types.
Determine the benefits of using temporary connections to achieve EV charging at events	Complete	• Multiple options considered for accommodating EV charging at events including timed connections, temporary connections and traditional network connections, with cost benefits found for DNOs, but costs still prohibitively high for event organisers.
Determine whether a demonstration project is appropriate	Complete	• The project found that a project to demonstrate network connections for accommodating EV charging was not appropriate as the battery storage solutions identified would be more commercially

		appealing to event organisers, therefore the methods trialled would be unlikely to be used following the trial.

6.2. Success Criteria

The Project has satisfied its success criteria as detailed in**Error! Reference source not found.**.

Table 6-2: Performance compared to project success criteria

Success Criteria	Met	Performance
A set of concept designs for providing temporary event charging at festivals for a number of case studies are presented	Complete	• Four concept designs presented for each of the three case studies selected within the project.
Capital costs are outlined for each design and this feeds into CBA in respect to DNOs and their customers	Complete	• Costs for each solution outlined, and a CBA carried out for each event to demonstrate the value for event organisers, DNOs and their customers.
Benefits of making temporary connections over existing methods of connection or on site generation are presented	Complete	• Temporary and timed connections assessed against other existing practices with benefits and limitations identified and presented.
Outline of how solutions will fit within WPD policy and PSD practices is documented	Complete	• Workshops used to identify how solutions fit within policy and design practices • Outcomes of this documented within the projects WP2 report and used to influence designs.
A conclusion is given on whether a trial is suitable for temporary connection solutions	Complete	• The project found that a project to trial temporary network connection solutions was not as alternative solutions identified would be more commercially appealing to event organisers and have fewer limitations, therefore the methods trialled would be unlikely to be used.

7. Required Modifications to the Planned Approach during the Course of the Project

There we no required modification to the planned approach during the course of this project.

8. Project Costs

The final costs for the Temporary Event Charging project can be seen in table 8-1 below:

Table 8-1: Project Spend

Activity	Budget	Actual	Variance
WPD Project Management Costs	£27,970.00	£27,051.78	-3%
Connected Kerb	£49,755.02	£49,755.02	0%
GHD	£29,476.00	£29,476.00	0%
Contingency	£10,720.30	£0.00	-100%
Total	£117,923.32	£106,284	-10%

The variance demonstrated is due to less project management time spent on the project than expected and there not being a need for the use of any contingency budget.

9. Lessons Learnt for Future Projects

The key points of learning from the project have been summarised in table 9-1 below. Further details can be found within the solution development report published on westernpower.co.uk/innovation.

Table 9-1: Project Learning Summary

Area	Learning Detail	Internal Outcomes
Event Engagement	On average 70% of festivalgoers travel by car. They travel between 70 and 140 miles - most travelling in an EV would need at least one charge to complete this round trip.	This was used in the assumptions for the number of vehicles requiring charging at each event and justification for the need for charging at events.
Event Engagement	Unlike internal combustion engine vehicle refuelling there is a need for EV charging at events due to timescales for charging and lack of availability of local charging infrastructure.	This formed part of the initial background research on the need and justification of charging at events.
Event Engagement	During COVID19 pandemic receiving engagement from events was challenging due to furloughed workers and cancelled events, where engagement did not provide all necessary data engagement with local councils and parking management companies was able to provide information.	Where event organisers are not contactable, local councils and parking management companies should be engaged on the project.
Case Study Development	Audience demographic is an important factor when considering the need for EV charging - some music festivals approached had a large number of young attendees leading to them being dropped off by parents or using public transport even if this would take a long time.	Some of the initial shortlisted events, including NASS festival, had to be disregarded as the number of attendees with EVs would not require significant charging infrastructure.
Case Study Development	Distance travelled to events and ranges of EVs demonstrate that not all will need charging at the event.	These considerations should be used to develop forecast EV demands for events.
Event Engagement	Difficulties with insurance and logistics mean that event organisers are not willing to have fast charging with vehicles charged in stages - preference to have more slower charging points.	The volume of EV chargers at events must be sufficient to charge vehicles without the need for rotation.
Policy Assessment	A review of existing policies has showed information relating to existing temporary connection methods for use under fault conditions including the use of a temporary 11kV substation (see standard technique SP1O for further details)	This formed a discussion point for workshop activities, but this use case involves connection to existing infrastructure to replace existing substations rather than facilitating new temporary connections.
Technical Workshop	Requirements in P2:7 would typically suggest that anything over 1MW would require a firm supply - therefore potential need for two 11kV supplies	When considering designs for event EV charging permanent network connections more than one point of connection may be required.
Technical Workshop	If the earthing system for a temporary substation is to be left in place, a way of ensuring that this is not stolen will need to be developed - holding within a substation building may lead to problems with redundant equipment - HSE have demonstrated safety issues in the past with this.	Temporary earthing systems cannot be left in place, so a cost associated with laying earthing conductors will be incurred at each instance of use.

Technical Workshop	Existing HV metering units at an 11kV primary substation supply could be used for battery recharging solutions.	Would provide a possible metering solution if events were to require charging for portable BESS at a nearby primary substation.
EVCP Design	Depending on the number of charging points required multiple options are available for a battery storage solution. This includes trailer mounted 90kWh units and containerised 610kWh solutions.	Different options available for battery storage solutions may have future use cases for fault restoration for DNOs.
EVCP Design	Temporary concrete footings for use on connection design and EVCP installations are possible without the need for significant civil works on site. It is expected that the unit cost for these reusable footings is around £450.	Information used within the case study design stages of this project.
Connection Design	The further away a temporary event is to the nearest 33/11kV primary substation, the higher the base case cost of traditional reinforcement i.e. to install and commission a new 11kV feeder to the event site. As the base case is a higher cost, the benefits of employing a BESS solution are greater.	It is a recommendation to perform a detailed technical assessment of the electrical infrastructure in the vicinity of the temporary event location prior to selection of the solution to ensure that the optimal solution is assessed.
Connection Design	Offering non-firm connections to events with controllable EVCP allows utilisation of the diversity in local network demand.	Reduction in overall connection and reinforcement costs where diversity allows enough capacity over the event dwell time.
Cost Benefit Analysis	Timed connections provide significant savings in the selected case studies, but further savings can be made using battery storage and primary substation connection	The suggested optimal solution for events involves the use of BESS rather than making network connections.
Charging Solution Design	Low power EV chargers (up to 7kW) are the most suitable solutions at temporary events given that EVs tend to have a long dwell time over the temporary event duration. These types of chargers can be installed and configured relatively quickly and with little disruption in a suitable parking location in proximity to the temporary event.	Recommendation for this capacity of EVCP for events rather than trying to charge vehicles faster which will then have delay before use.
Charging Solution Design	EV chargers should ideally be located for best access for the power source, either based on optimal cable connection to a substation or easiest access for the vehicles delivering the BESS. Another key consideration for the installation location is ensuring access for disabled drivers is not restricted or compromised by the roll-out of on-site EV charging infrastructure.	Space for BESS, proximity to existing distribution network, and location of accessible parking are all key considerations when selecting positions for EVCP at events.

10. The Outcomes of the Project

Work Package one of the Temporary Event Charging project demonstrated the need for facilitating EV charging at temporary events, and confirmed that historically this has only been carried out at a few events on a very small scale. Following the case study selection process in Work Package one, and using feedback from event organisers and stakeholders, Work Package two then carried out the solution designs for each case study and analysed its costs. This led to the following main conclusions:

- Our research and CBA has led us to the conclusion that portable BESS are the optimal power solution to supply forecast EV charging demand at temporary events.
- The BESS solution was beneficial both technically and financially when compared to the other solutions namely temporary and permanent network connections to the local 11kV network.
- New network connections to supply the forecast EV demand were found to be significantly more expensive even when a temporary event is located in close proximity to an existing primary or secondary distribution substation. The new network connection designs required the installation of secondary distribution substations and associated 11kV overhead lines (OHL) and/or cabling that was deemed cost-prohibitive for the very short duration the assets are utilised for over the year.
- Our investigation has shown low power EV chargers (up to 7kW) are the most suitable solutions at temporary events given that EVs tend to have a long dwell time over the temporary event duration. These types of chargers can be installed and configured relatively quickly and with little disruption in a suitable parking location in proximity to the temporary event. Charging infrastructure is most easily deployed where it is surface mounted, self-weighted and interconnected with concrete and rubber cable tracks to hold the equipment safely and securely in place.
- The location of the chargers should ideally be located for best access for the power source, either based on optimal cable connection to a substation or easiest access for the vehicles delivering the BESS. A key consideration for the installation location is ensuring access for disabled drivers is not restricted or compromised by the roll-out of on-site EV charging infrastructure.

One of the overall aims of this feasibility study was to provide recommendations on whether a future trial should be carried out. The project found that a leased BESS solution would be the most cost-effective solution for the Distribution Network Operator (DNO) as this option does not require the installation of additional network infrastructure, and event organisers who would benefit from the lowest capital and operating costs. This would likely be carried out by a third party that has the experience of installing and configuring BESS solutions. Therefore, the DNO will not have any role in the provision of the EV charging infrastructure at the event site. It has therefore been found that there is no scope for a future NIA funded trial as any future work would need to be funded directly by the events industry in coordination with their EV charging delivery partners.

Full learning and outputs from the project have been disseminated via the WPD innovation webpage reporting, allowing other DNOs to benefit from the learning generated without the need for duplication of any work.
www.westernpower.co.uk/projects/temporary-event-charging

11. Data Access Details

The detailed report on the completion of Temporary Event Charging can be found on the project page on the WPD Innovation website: www.westernpower.co.uk/projects/temporary-event-charging

No new data about the network or consumption has been gathered in the course of this Project, but rather use has been made of existing data within WPD's systems.

Detailed network plans used are available via our Data Portal which can be found here: https://www.westernpower.co.uk/our-network/network-plans-and-information

12. Foreground IPR

No foreground IPR has been developed as part of this project.

13. Contact

Further details on this project can be made available from the following points of contact:

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Glossary

Abbreviation	Term
Ofgem	Office of Gas and Electricity Markets
NIA	Network Innovation Allowance
EV	Electric Vehicle
WP	Work Package
BESS	Battery Energy Storage System
CBA	Cost Benefit Analysis
NPV	Net Present Value
RIIO-ED1	Ofgem Price Control Period 2015-2023
DNO	Distribution Network Operator
GHD	Gutteridge, Haskins & Davey Limited
WPD	Western Power Distribution
PSD	Primary System Design
EVCP	Electric Vehicle Charging Point
HV	High Voltage
kV	kiloVolt
OHL	Overhead Line
IP	Intellectual Property.

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